International Journal of Applied Mathematics, Sciences, and Technology for National Defense
Volume 1, Issue 2, 37-44.
e_ISSN: 2985-9352, p_ISSN: 2986-0776
https://www.journal.foundae.com/index.php/JAS-ND
DOI : https://doi.org/10.58524/app.sci.def.v1i2.169

Antibiotic resistance patterns of *staphylococcus aureus* in chicken farms: Implications for health resilience in Indonesia

Tiara Rahayu
Indonesia Defense University,
INDONESIA

M. Ridhwan Amarullah
Indonesia Defense University,
INDONESIA

Alexander Yabansabra
Indonesia Defense University,
INDONESIA

Aparna Dixit
Pranveer Singh Institute of Technology
INDIA

Muhamad Syazali*
Indonesia Defense University,
INDONESIA

Nabila Swarna Puspa Hermana
Indonesia Defense University,
INDONESIA

Article Info

Article history:

Received: May 11, 2023
Revised: July 20, 2023
Accepted: July 26, 2023

Keywords:

Antibiotics
Chicken
Health resilience
Resistance
Staphylococcus aureus

Abstract

Health resilience refers to an individual's or a community's ability to withstand and recover from various health challenges and crises. Antibiotic resistance poses a significant threat to health resilience due to its impact on the effectiveness of antibiotics. The urgency of the issue of multidrug bacterial resistance in public health is a concern. The phenomenon discussed in this paper is related to the environment that becomes resistant to the antibiotic *staphylococcus aureus* which causes high morbidity and mortality in animals such as chickens. In this study, there were three levels of antibiotic resistance based on clear zone media culture, namely resistance, intermediates, and sensitivity with each antibiotic totaling nine chicken cloacal swab samples. The purpose of this study was to determine the pattern of the significance of antibiotic resistance in *S. aureus* in three chicken farms in West Java Province (Bogor, Parung, and Sukabumi). This study used secondary data from previous studies and analyzed with nonparametric statistical methods using the Kruskal Wallis Test (One Way ANOVA). The results of the analysis showed almost all gave a resistant response characterized by the absence of a clear zone in bacterial culture media treated with the same antibiotic in all chicken cloaca swab samples taken from farms in Bogor, Parung, and Sukabumi. Thus, resulting in the same resistance pattern. This indicates the pattern of the resilience of resistance in West Java is the same because the ecological conditions and living standards of the community are almost the same. These results may illustrate important concerns for the possibility of other regions in Indonesia having similar patterns of antibiotic resistance, so antibiotic use must adhere to appropriate guidelines to combat further antibiotic-resistant strains.

To cite this article: Rahayu, T., Amarullah, M. R., Yabansabra, A., Syazali, M., & Hermana, N. S. P. (2023). Antibiotic resistance patterns of staphylococcus aureus in chicken farms: Implications for health resilience in Indonesia. *International Journal of Applied Mathematics, Sciences, and Technology for National Defense , 1* (2), 37-44.

INTRODUCTION

Chicken meat is one of the sources of animal food which is a basic need for the people of Indonesia. Based on data from the Central Statistics Agency in 2022, West Java Province is known as the province with the largest poultry population as follows, free-range chickens 28,850,898 heads, laying hens 47,568,124 heads, broilers 617,566,755 heads. The largest laying hen population is in Bogor Regency with 18,414,148 heads in 2022 (BPS, 2022). To

***Corresponding Author**
Muhamad Syazali, Indonesian Defense University, INDONESIA, Email: Muhamad.syazali@idu..ac.id

meet the high needs of the community in the demand for chicken meat, the livestock industry sector must be able to improve chicken health to avoid disease and bacterial infection with antibiotics. The main purpose of giving antibiotics to livestock is in order to reduce the risk of death and restore the condition of livestock to return to health. Antibiotics in the livestock industry are given in order to spur growth as feed additives, increase the efficiency of feed use and increase production. The antibiotics most commonly found in meat are tetracycline-type antibiotics (including chlortetracycline and oxytetracycline) (Nadzifah et al., 2019). The antibiotics used in this study are commonly used by breeders in Indonesia, such as erythromycin, tetracycline, penicillin, and doxycycline. *S. aureus* in the study was least resistant to gentamicin and chloramphenicol, which are the antibiotics least used in poultry (Hermana et al., 2021). Antibiotics are still allowed to be used as drugs in livestock but must be in accordance with supervision. Because of the many dangers that can occur due to antibiotic residues in products of animal origin, a farmer must know and understand the rules for using antibiotics (Pertanian & Indonesia, 2017). The phenomenon that occurs today is that there are many cases of negligence in the use of wrong and inappropriate antibiotics to cause resistance. Multi-drug-resistant bacteria are an important issue in public health because they occur in animals, humans, and the environment. The incidence of antibiotic resistance can be minimized by combination drug administration, rational drug prescribing, controlling patient adherence, strict regulatory mechanisms, and efficient drug education and supervision systems (Agustina et al., 2019). Other factors such as antibiotic trafficking, increased international travel, poor sanitation and hygiene, and antibiotic residues released into the environment can contribute to antibiotic resistance and the emergence of multidrug-resistant strains. Antibiotics are still allowed to be used as drugs in livestock but must be in accordance with supervision. Because of the many dangers that can occur due to antibiotic residues on products of animal origin. A farmer must know and understand the rules for using antibiotics (Pertanian & Indonesia, 2017).

S. aureus is a Gram-positive bacterium that is opportunistic pathogenic in humans as well as animals, a serious cause of infection, especially since the emergence of methicillin-resistant *S. aureus* antibiotics *(MRSA)* (Lade & Kim, 2021). It is considered the third most common pathogen causing food poisoning in the world. *S. aureus* (SA) infections have shown a dramatic increase in the last decade. The burden of infection due to methicillin-resistant SA strains (MRSA) is significantly more severe in children compared to other age groups. *S. aureus* is also a significant cause of morbidity and mortality in animals. This is especially important for the livestock/food industry, as outbreaks can result in real economic losses. *S. aureus* develops resistance very quickly and successfully to different antimicrobials over a period of time. The highest frequency of *S. aureus* occurred with susceptibility to the antimicrobial agent Levofloxacin (100%) followed by Ciprofloxacin (78.9%) while the least was Penicillin (7.1%) (Access, 2011). The development of resistance by *S. aureus* raises a warning for the medical community to begin to be more concerned and careful in terms of choosing appropriate antibiotics. In areas that do not have a bacterial culture research center, it is quite difficult for doctors to determine the right antibiotic treatment if they find MRSA cases (Santika et al., 2014). The cattle-associated MRSA strain (LA-MRSA) was first described in the early 2000s in cattle. It is now known that veterinarians, people who work on farms, or anyone who comes into contact with animals or pets, who carry LA-MRSA are at risk of contracting it (Cuny et al., 2015).

As is known from comparative genomic analysis, LA-MRSA has evolved from methicillin-susceptible *S. aureus* adapted to humans. This is due to genetic changes. The return of genetic changes and adaptation back to humans has potential health risks and requires close supervision. Although most LA-MRSA (>80%) are resistant to some antibiotics, there are still sufficient treatment options (Cuny et al., 2015). To combat the

further emergence of antibiotic-resistant strains, it is necessary to carry out cellular processes of *S. aureus* that are not targeted by current antibiotics in clinical use (Lade & Kim, 2021).

The purpose of this study was to analyze the significance of *S. aureus* antibiotic resistance from samples of chicken farms in Bogor, Parung, and Sukabumi. Antibiotics are widely used to fight infections caused by *S. aureus*, such as penicillin, erythromycin, and tetracycline. Unfortunately, farmers also use antibiotics in poultry as prophylaxis and growth promoters. However, widespread use of antibiotics with improper procedures can drive an increase in antibiotic-resistant bacteria (Wongsuvan et al., 2018). Erythromycin, tetracycline and penicillin-G are some of the antibiotics used to treat infections in poultry. In this study, antibiotic resistance levels of *S. aureus* will be tested on chicken cloacal swab samples at farms in West Java, namely Bogor, Parung and Sukabumi. Determining this level of significance is very important to determine the potential spread of antibiotic resistance in each livestock area in Indonesia to detect and monitor the occurrence of antibiotic resistance in the livestock sector.

Similar studies have been conducted by (Wijiati et al., 2021) by using cloacal swabs of birds, where isolates have characteristics corresponding to *positive coagulase Staphylococcus* as evidenced by measurements of the diameter of the inhibitory zone formed around the antibiotic disc and research conducted by (Agustina et al., 2019) related to the detection of *S. aureus* as a gram-positive bacterium that is pathogenic and has the potential to cause pneumonia infection in humans.

METHODS

A nonparametric test is a statistical analysis method that does not require the assumption of normally distributed data as an alternative to parametric tests. The nonparametric statistical method used is the Kruskal Wallis Test, a one-way analysis of variance or One Way Anova used to determine the independence of two or more samples with different distributions (Aisyah et al, 2023). The data collection process is taken from original research conducted by research results as secondary data. Furthermore, statistical method analysis is carried out so that the data can be interpreted according to the objectives of this study.

RESULTS AND DISCUSSION

The results of statistical method analysis are displayed with several tables as follows. Based on the results of research conducted by (Hermana et al., 2021) can be interpreted in the Table 1. Secondary data with antibiotic clear zone parameters in *S. aureus* in Parung, Sukabumi and Bogor are sensitive, intermediates and resistant.

Table 1. Secondary data based on clear zone parameter antibiotics are sensitive, intermediates, resistant

Parameters	Antibiotic	Parung	Bogor	Sukabumi
SENSITIVE	TET	0	1	0
SENSITIVE	OT	0	1	0
SENSITIVE	AMP	0	0	0
SENSITIVE	CN	15	12	9
SENSITIVE	NA	0	0	1
SENSITIVE	ENR	4	1	1
SENSITIVE	CIP	4	4	2
SENSITIVE	E	0	0	0

SENSITIVE	C	13	7	8
INTERMEDIATES	TET	0	0	0
INTERMEDIATES	OT	0	0	0
INTERMEDIATES	AMP	0	0	0
INTERMEDIATES	CN	0	0	0
INTERMEDIATES	NA	0	1	0
INTERMEDIATES	ENR	0	5	3
INTERMEDIATES	CIP	5	2	2
INTERMEDIATES	E	0	0	1
INTERMEDIATES	C	0	2	3
RESISTANT	TET	15	14	14
RESISTANT	OT	15	14	14
RESISTANT	AMP	15	15	14
RESISTANT	CN	0	3	5
RESISTANT	NA	15	14	13
RESISTANT	ENR	11	9	10
RESISTANT	CIP	6	9	10
RESISTANT	E	15	15	13
RESISTANT	C	2	6	3

Note: TET (Tetracycline), OT (Oxytetracycline), AMP (Ampicillin), CN(Gentamycin), NA (Nalidixic acid), ENR (Enrofloxacin), CIP (Ciprofloxacin), E(Erythromycin), C (Chloramphenicol)

Nonparametric analysis results with Kruskal Wallis Test (One Way ANOVA)

Variable: Parung

H0: $\theta D = 0$: The sample comes from a population with the same median

H1: $\theta D \neq 0$: Samples came from populations with a median that was not all the same

Table 2. Statistics test in Parung

Parameter	Value
H	10.173
CF	0,850
H Adjusted	11.966
Df	2
p-Value	0,003
Critical Value	5.991

Based on the Table 2, the result was significant at a p-value of < 0.05, Since the p-value (0.003) is < (0.05), there is insufficient evidence to suggest that the population median difference differs from 0, at the significance level = 0.05. Thus, showing a significant influence of resistance, intermediate and sensitive levels in the Parung area with p-Value of 0.003.

Place variable: Bogor
H0: θD = 0: The sample comes from a population with the same median
H1: θD ≠ 0: The sample comes from a population with a median that is not all the same

Table 3. Statistics test in Bogor

Parameter	Value
H	14.649
CF	0,969
H Adjusted	15.115
Df	2
p-Value	0,001
Critical Value	5.991

Based on the Table 3, the result was significant at a p-value < 0.05. Since the p-value (0.001) is < (0.05), there is insufficient evidence to suggest that the population median difference differs from 0, at the significance level = 0.05. Thus, showing a significant influence on the level of resistance, intermediate and sensitive in the Bogor area with p-Value of 0.001.

Table 4. Multiple comparisons in three group based on clear zone antibiotics

Group	N	Mean	Mean Rank	Sum Ranks
INTERMEDIATES	9	1,11	8,56	77,00
RESISTANT	9	11,00	22,11	199,00
SENSITIVE	9	2,89	11,33	102,00

Based on the Table 4, in the Bogor area showed the nine antibiotics resistance to *S. aureus* with a mean of 11.

Place variable: Sukabumi
H0: θD = 0: The sample comes from a population with the same median
H1: θD ≠ 0: The sample comes from a population with a median that is not all the same

Table 5. Statistics test in Sukabumi

Parameter	Value
H	15.429
CF	0,959
H Adjusted	16.093
Df	2
p-Value	0.0001
Critical Value	5.991

Based on the Table 5, the result was significant at a p-value < 0.05, Since the p-value (0.0001) < (0.05), there is insufficient evidence to suggest that the median difference in population differs from 0, at a significance level = 0.05. Thus, showing a significant influence on the level of resistance, intermediate, and sensitive in the Sukabumi area with a p-Value of 0.0001.

Table 6. Multiple comparisons in three group based on clear zone antibiotics

Group	N	Mean	Mean Rank	Sum Ranks
INTERMEDIATES	9	1,00	9,06	81,50
RESISTANT	9	10,67	22,44	202,00
SENSITIVE	9	2,33	10,50	94,50

Based on the Table6, in the Sukabumi area showed the nine antibiotics resistance to *S. aureus* with a mean of 10,67

CONCLUSION

There was no difference in the significance of antibiotic resistance in *Staphylococcus aureus* between chicken farms in Bogor, Parung, and Sukabumi. The results showed that all antibiotics were resistant to *S. aureus* at all. This is an important concern, because it is likely that other regions in West Java have the same pattern of antibiotic resistance levels. This is possible because the ecological conditions and living standards of the people are almost the same. The results of this study may illustrate the important concern for the livestock industry in the use of antibiotics that must adhere to appropriate guidelines to combat further antibiotic-resistant strains. There is still a lack of information on the pattern of antibiotic resistance of *S. aureus* isolated from poultry in Indonesia.

The findings in this study suggest that antibiotic resistance rates are alarming and increasing almost equally in every region. The study can also be applied in other regions of Indonesia to provide national data on antibiotic resistance in Indonesia. Further research can also be conducted to determine the best solutions to manage and reduce antibiotic resistance.

AUTHOR CONTRIBUTIONS

The publication of our paper cannot be separated from the contributors who have helped in completing this research. Thanks to authors who has assisted in collecting and processing data in statistical software R. And to the corresponding author in assisting in writing and interpreting research results.

REFERENCES

Access, O. (2011). Staphylococcus aureus. 8688, 1–7.

Agustina, D., Mufida, D., Rizki, H., & Dharmawan, D. (2019). Antibiotic Sensitivity Test on *Staphylococcus aureus* Detected in Sputum of Patients with Pneumonia Treated in Hospitals. *Journal of Agromedicine and Medical Sciences*, 5(1), 20-24. https://doi.org/10.19184/ams.v5i1.9267

Aisyah, M. A., Putri, D. A., Chandra, Y., Syazali, M., Machmud, A., & Rachmawati, R. N. (2023). Mixed linear model for investigating food security during the covid-19 pandemic: Panel data for rice consumption in indonesia. *International Journal of Applied Mathematics, Sciences, and Technology for Defense.* 1(1), 29-36. https://doi.org/10.58524/app.sci.def.v1i1.174

Wijiati, A. M., Afiff, U., & Mustika, A. A. (2021). Pola resistensi *Staphylococcus koagulase* positif yang diisolasi dari burung lovebird terhadap beberapa antibiotik. *ARSHI Veterinary Letters*, 5(1), 15–16. https://doi.org/10.29244/avl.5.1.15-16

Badan Pusat Statistika. 2022. Populasi Ternak Unggas di Jawa Barat (ekor) Tahun 2020-2022. Retrieved from https://jabar.bps.go.id/indicator/158/258/1/populasi-ternak-unggas-di-jawa-barat.html (15) [15 Juni 2023]

Bounar-kechih, S., Hamdi, M. T., Aggad, H., Meguenni, N., & Cantekin, Z. (2018). Carriage Methicillin-Resistant *Staphylococcus aureus* in Poultry and Cattle in Northern Algeria. Veterinary Medicine

International, 2018, 1-6. https://doi.org/10.1155/2018/4636121

Cuny, C., Wieler, L. H., & Witte, W. (2015). Livestock-Associated MRSA: The Impact on Humans. *Antibiotics,* 4(4), 521–543. https://doi.org/10.3390/antibiotics4040521

Ditjen PKH (Direktorat Jenderal Peternakan dan KesehatanHewan). 2018. Berdampak negatif bagi kesehatan, pemerintah larang penggunakan AGP pada ternak. Retrieved from https://ditjenpkh.pertanian.go.id/berita/734-berdampak-negatif-bagi-kesehatan-pemerintah-larang-penggunakan-agp-pada-ternak#! [15 Juni 2023]

Gajdács, M. (2019). The continuing threat of methicillin-resistant *Staphylococcus Aureus*. *Antibiotics*, 8(2), 52. https://doi.org/10.3390/antibiotics8020052

Hermana, N. S. P., Afiff, U., Safika, S., Indrawati, A., & Pasaribu, F. H. (2021). Antibiotic resistant Pattern and resistant gene identification of *Staphylococcus aureus* from chicken farm in Bogor. *Jurnal Veteriner*, 22(2), 262–270. https://doi.org/10.19087/jveteriner.2021.22.2.262

Lade, H., & Kim, J. S. (2021). Bacterial targets of antibiotics in methicillin-resistant *Staphylococcus aureus*. *Antibiotics*, 10(4), 398. https://doi.org/10.3390/antibiotics10040398

Nadzifah, N., Sjofjan, O., Djunaidi, I. H., Pascasarjana, M., Peternakan, F., Malang, U. B., Peternakan, D. F., & Malang, U. B. (2019). Kajian residu antibiotik pada karkas broiler dari beberapa kemitraan di kabupaten Blitar. 20(2), 165–171. https://doi.org/10.21776/ub.jtapro.2019.020.02.9

Pertanian, K., & Indonesia, R. (2017). Kajian Residu Antibiotika pada Produk Ternak Unggas di Indonesia. 05(1), 29–33.

Ramirez, A. A. (2018). Use of antibiotics in broiler production : Global impacts and alternatives. *Animal Nutrition*, 4, 170–178. https://doi.org/10.1016/j.aninu.2018.03.002

Santika, I. K. J., Januartha, K., Pinatih, P., Nengah, N., & Fatmawati, D. (2014). Pola Kepekaan Methicillin-Resistant *Staphylococcus aureus* terhadap Antibiotika di RSUP Sanglah pada Agustus 2013-Oktober 2013. *E-Jurnal Medika Udayana*, 3(7). https://ojs.unud.ac.id/index.php/eum/article/view/9816

Wongsuvan, G., Wuthiekanun, V., Hinjoy, S., Day, P. J. N., & Limmathurotsakul, D. (2018). Antibiotic use in poultry: a survey of eight farms in Thailand. 96(2), 94–100. 10.2471/BLT.17.195834